What is claimed is:

1. A method of estimating flexure life of a wire harness in which, in the case when a wire bundle, formed by binding a plurality of wires each formed by coating a conductor line with an insulating layer, is allowed to pass through a predetermined protective tube and secured to an external structural member different from said protective tube, the flexure life up to disconnection caused by extending and bending processes of said wire bundle caused by operations of said external structural member is estimated in accordance with a finite element method, comprising:

an initial shape determining step of:

using an initial shape of a center line of said wire bundle as a substitute for an initial shape of said wire bundle so as to be determined, using an initial shape of a virtual pipe having only a margin dimension of a margin space of said protective tube with respect to said wire bundle as an inner diameter as a substitute for an initial shape of said protective tube so as to be determined, determining an initial shape of a center line of said wire bundle so that the center line of said wire bundle is not limited by two end portions of the virtual pipe, and determining an initial shape of said external structural member;

an extending and bending operation analyzing step of: analyzing extending and bending shapes of said wire bundle and said protective tube by virtually estimating operations of said external structural member so as to calculate a change in curvature of said wire bundle;

a calculation step of an amount of change in strain for calculating an amount of change in strain of said wire bundle that is a subject for estimation based upon the change in curvature obtained through said extending and bending operation analyzing

step; and

a collation step of: making a collation on a life estimation curve that is preliminarily set based upon said amount of change in strain calculated in said calculation step of an amount of change in strain so as to predict the flexure life of said wire bundle.

2. The method of estimating flexure life of a wire harness according to claim 1, wherein, in said extending and bending operation analyzing step, a change in curvature of a center line of the wire bundle is used as a substitute for said change in curvature of the wire bundle.

3. The method of estimating flexure life of a wire harness according to claim 1 or 2,

wherein: said life estimation curve represents correlation between the amount of change in strain and said number of bending processes with respect to a single wire that is obtained by actually measuring the number of bending processes up to disconnection by repeatedly bending said single wire with respect to a plurality of amounts of change in strain; and

in said calculation step of an amount of change in strain, a virtual line member, formed by subjecting the respective bending modulus of elasticity of said conductor line and said insulating layer to weighting processes and averaging processes by using ratios of cross-sectional areas, is assumed, and on the assumption that the virtual line member serves as one of said wires, supposing that the bending radius is R_1 in any one of the wires in the furthest bent state at the position that is subjected to the greatest change in bending within an area in which said virtual line member is subjected to

bending, that the bending radius is R_2 in the single wire in the furthest extended state, and that the radius of any one of wires that has the greatest difference between said value R_1 and said value R_2 is r, said amount of change in strain ($\Delta\varepsilon$) is calculated by the following equation:

$$\Delta\varepsilon = r \cdot (1/R_1 - 1/R_2)$$

4. A method of estimating flexure life of a wire harness, which includes a wire having at least a center conductor line in the center thereof with strands twisted on the periphery of the center conductor line, and has a function for estimating flexure life up to disconnection of said wire due to bending and extending processes, comprising the steps of:

preliminarily obtaining a correlation between an amount of change in strain of a single wire that is made of the same material as said center conductor line and actual measured values of flexure life;

calculating the greatest amount of change in strain of said center conductor line of a wire serving as a subject for the estimation; and

estimating flexure life of said wire by collating said calculated greatest amount of change in strain of said center conductor line with said correlation.

5. A method of estimating flexure life of a wire harness, which includes a wire bundle formed by binding a plurality of wires, each having a central conductor line in the center thereof, and has a function for estimating flexure life up to disconnection of said wire bundle, comprising the steps of:

preliminarily obtaining a correlation between an amount of change in strain of a

single wire that is made of the same material as said center conductor line and actual measured values of flexure life;

calculating the greatest amount of change in strain of said center conductor line of a single wire that is assumed to have the greatest change in curvature radius upon being bent among the wires within the wire bundle serving as a subject for the estimation; and

estimating flexure life of said wire bundle by collating said calculated greatest amount of change in strain of said center conductor line of said wire with said correlation.

6. The method of estimating flexure life of a wire harness according to claim 4 or 5,

wherein, in said step of obtaining the correlation, said single wire is repeatedly bent with respect to a plurality of amounts of change in strain to actually measure the number of bending processes up to disconnection so as to obtain the correlation.

7. The method of estimating flexure life of a wire harness according to any one of claims 4 to 6,

wherein, in said calculation step of the greatest amount of change in strain, supposing that the center conductor line has a radius of r, that the bending radius is R_1 in said center conductor line in the furthest bent state at the position that is subjected to the greatest change in bending within an area in which said center conductor line is subjected to bending, and that the bending radius is R_2 in said center conductor line in the furthest extended state, said greatest amount of change in strain ($\Delta \varepsilon$) is calculated by the following equation:

$$\Delta \varepsilon = r \cdot (1 / R_1 - 1 / R_2)$$

8. A wire harness designing method, which is used for designing a wire harness in which a single or a plurality of wires, each formed by coating a conductor line with an insulating layer, are bound and placed on a desired application subject, comprising:

an application subject design planning step of planning a design of said application subject as a whole;

a wire harness design planning step of planning a design of said wire harness so as to fit to said application subject; and

a flexure life estimating step of, in the case when said wire harness planned in said wire harness design planning step is allowed to pass through a predetermined protective tube and secured to an external structural member different from said protective tube, estimating flexure life up to disconnection caused by extending and bending processes of said wire harness in accordance with a finite element method,

said flexure life estimating step comprising:

an initial shape determining step of: using an initial shape of a center line of said wire harness as a substitute for an initial shape of said wire harness so as to be determined, using an initial shape of a virtual pipe having only a margin dimension of a margin space of said protective tube with respect to said wire harness as an inner diameter as a substitute for an initial shape of said protective tube so as to be determined, determining an initial shape of a center line of said wire harness so that the center line of said wire harness is not limited by two end portions of the virtual pipe, and determining an initial shape of said external structural member;

an extending and bending operation analyzing step of: analyzing extending and

bending shapes of said wire harness and said protective tube by virtually estimating operations of said external structural member so as to calculate a change in curvature of said wire harness;

a calculation step of an amount of change in strain for calculating an amount of change in strain of said wire harness that is a subject for estimation based upon the change in curvature obtained through said extending and bending operation analyzing step; and

a collation step of: making a collation on a life estimation curve that is preliminarily set based upon said amount of change in strain calculated in said calculation step of an amount of change in strain so as to predict the flexure life of said wire harness.

9. A wire harness designing method, which is used for designing a wire harness in which a single or a plurality of wires, each formed by coating a conductor line with an insulating layer, are bound and placed on a desired application subject, comprising:

an application subject design planning step of planning a design of said application subject as a whole;

a wire harness design planning step of planning a design of said wire harness so as to fit to said application subject; and

a flexure life estimating step of estimating flexure life of said wire harness planned at said wire harness design planning step up to disconnection caused by extending and bending processes of said wire harness in accordance with a finite element method,

said flexure life estimating step comprising:

an initial shape determining step of determining an initial shape of said wire

harness;

an extending and bending operation analyzing step of: analyzing extending and bending shapes of said wire harness so as to calculate a change in curvature of said wire harness;

a calculation step of an amount of change in strain for calculating an amount of change in strain of said wire harness that is a subject for estimation based upon the change in curvature obtained through said extending and bending operation analyzing step; and

a collation step of: making a collation on a life estimation curve that is preliminarily set based upon said amount of change in strain calculated in said calculation step of an amount of change in strain so as to predict the flexure life of said wire harness.

10. The wire harness designing method according to claim 8 or 9,

wherein: said application subject design planning step and said wire harness design planning step are executed by an application subject designing station for designing and planning said application subject, and said flexure life estimating step is executed by a wire manufacturing station for manufacturing said wire harness or said application subject designing station.

11. The wire harness designing method according to any one of claims 8 to 10,

wherein in said extending and bending operation analyzing step in said flexure life estimating step, said change in curvature of the center line of said wire bundle is used as a substitute for said change in curvature of the wire bundle.

12. The wire harness designing method according to any one of claims 8 to 11, wherein: in said flexure life estimating step, said life estimation curve represents correlation between the amount of change in strain and said number of bending processes with respect to a single wire that is obtained by actually measuring the number of bending processes up to disconnection by repeatedly bending said single wire with respect to a plurality of amounts of change in strain; and

in said calculation step of an amount of change in strain in said flexure life estimating step, a virtual line member, formed by subjecting the respective bending modulus of elasticity of said conductor line and said insulating layer to weighting processes and averaging processes by using ratios of cross-sectional areas, is assumed, and on the assumption that the virtual line member serves as one of said wires, supposing that the bending radius is R_1 in any one of the wires in the furthest bent state at the position that is subjected to the greatest change in bending within an area in which said virtual line member is subjected to bending, that the bending radius is R_2 in the single wire in the furthest extended state, and that the radius of any one of wires that has the greatest difference between said value R_1 and said value R_2 is r, said amount of change in strain ($\Delta \varepsilon$) is calculated by the following equation:

$$\Delta \varepsilon = r \cdot (1 / R_1 - 1 / R_2)$$

13. The wire harness designing method according to any one of claims 8 to 12, wherein in said initial shape determining step of said flexure life estimating step, the initial shape of said wire harness is determined based upon at least the diameter of said wire harness, the diameter of said wire harness being calculated through a predetermined arithmetic expression based upon the number and diameters of a

plurality of kinds of wires constituting the wire harness.

14. The wire harness designing method according to claim 8,

wherein in said initial shape determining step of said flexure life estimating step, said margin dimension is found by subtracting the diameter of said wire harness from the inner diameter of said protective tube, the diameter of said wire harness being calculated through a predetermined arithmetic expression based upon the number and diameters of a plurality of kinds of wires constituting the wire harness.

15. The wire harness designing method according to claim 14,

wherein supposing that the respective wires constituting said wire harness have a diameter of d_v, that the number of the respective wires having the diameter d_v is N_v, and that a predetermined coefficient is a_i, the diameter D_x of said wire harness is calculated by the following equation:

[Equation 2]

$$D_0 = \{\sum_{v=1}^{m} (d_v^2 \times N_v)\}^{1/2}$$

$$Dx = \sum_{i=1}^{n} (a_i \times D_0^i)$$

16. The program for allowing a computer to execute the respective steps within the flexure life estimating step in order to realize said flexure life estimating step on the computer in a wire harness designing method disclosed in any one of claims 8 through 15.